

META-EVI

Innovative Performance Paths with a Wind Controller

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ABSTRACT

The META-EVI is a novel interface created from an extensive augmentation of the Steiner MIDI EVI, a brass style 'electric valve instrument' (EVI), which was expanded with 11 analog sensors and 10 digital switches. The main goal of this project consists in achieving a performance tool that exhibits truly innovative levels of musical expression much beyond what is possible with the original instrument. By allowing the control of a great variety of musical parameters, the META-EVI is able to push the level of musicianship associated with the player of a monophonic wind instrument, to a new plateau of musical complexity.

Keywords

Musical Instrument, Sensor technologies, Computer Music, Software Design.

1. THE EVI and MIDI EVI

The idea of a wind driven electronic synthesizer, known today as a wind controller, was conceived by American engineer and trumpeter Nyle Steiner, who completed his first playable EVI, the 'Steiner Horn' [1], in 1975. This instrument was a monophonic electronic controller that used the valve-technique found in brass instruments as the main control interface. A woodwind version, the EWI, implementing the Boehm system was developed soon after. The success and musical prowess of these instruments can be easily understood when one considers that jazz giants, such as saxophonists Bob Mintzer and the late Michael Brecker, among others, have regularly played with them. Back in the 80's through the mid 90's, those instruments were voltage-driven analog controllers that needed special sound modules to translate and create sound according to those voltages. In the late 1990's Nyle Steiner created a MIDI version of the EVI, the MIDI EVI [1] that enabled the wind controller to be connected directly to MIDI gear.

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NIME08, June 5-7, 2008, Genova, Italy

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2. THE META-EVI

The META-EVI keeps all of the original MIDI EVI's sensors, such as the breath pressure sensor and the bite sensor found on its mouthpiece, the touch/capacitance sensors for the fingering/key system and also capacitance sensors that generate pitch bend, glissando and vibrato.

The META-EVI modification adds 11 analog sensors and 10 digital switches. These are as follows:

- 1 Accelerometer with Tilt detection
- 1 Gyroscope
- 1 Force Resistance Sensor
- 3 Position membrane sensors
- 1 Joystick
- 2 Linear Potentiometers
- 10 On/Off tactile switch buttons



Figure 1. Top view: virtual valves, accelerometer, gyro, FSR

3. FUNDAMENTAL GOALS

The choice of sensors to extend the capabilities of the MIDI EVI were thought out to have two main objectives. The first is the attempt to change the paradigm of the player of a monophonic wind/brass instrument. For over half a century now, there have been created 'extended techniques' both for brass and woodwind acoustic instruments, such as multi-phonics, playing and singing simultaneously, etc, etc. These techniques were created with the purpose of surpassing the "limitations" of those instruments and they have clearly widen the musical palette available to the musician. Nonetheless,

because they are sonically unsteady, technically difficult, or at times insufficiently expressive, they fail at being able to create a new performance model. By conquering specific new levels of performance techniques the META-EVI presents innovative solutions for the player of a monophonic instrument. These include among others, playing complex harmonic structures while simultaneously playing a lead melody, a process where the two strands are played in real time and totally asynchronous from each other.

Attempts to tackle this particular issue have been realized with some commercial electronic instruments but with very limited results. Specifically with the AKAI EWI 3020 [2] (an offspring of the early EWI) or the Syntophone [3]. These instruments are able to trigger a previously stored stack of notes in a sound module when a specific pitch is played. This approach, although allowing the playback of some harmonic material presents very little flexibility.



Figure 2. Side view: joystick and 3-membrane sensor

The second goal for the creation of the META-EVI was the intention of gathering and taking full advantage of the gestures and body motions that are naturally used by a performer of a brass/wind instrument. These gestures are always present and very visible and they are used to directly influence various parameters of the software application that controls the ongoing performance.

4. PLAYING THE META-EVI

The META-EVI is played by blowing through its mouthpiece, and fingering four touch sensors or virtual “valves”, which allow the production of the 12 chromatic steps. Three of those valves or keys, sit on top of the instrument and are the equivalent of the three valves of a regular trumpet that are played with the index, middle and ring fingers of the musician’s right hand. The fourth valve (that lowers the pitch by a fourth) consists of a metal ring snug against the lower edge of the instrument, and it is accessed by the index finger of the player’s left hand.

The instrument is supported mainly with the left hand, which holds the canister - a cylinder shaped component located at its bottom edge. The controller has a pitch span of seven full octaves with octave switching being done by sliding the thumb of the left hand on a set of six metal rollers (also touch sensors) that are housed inside the canister.

4.1 The extra analog sensors

While most of the extra sensors and switches are placed at specific places in order to be easily accessed by the fingers of the musician, both the *accelerometer* and *gyroscope* placement was chosen to fully optimize their readings as a function of the performer’s motions. The *accelerometer* sits at the end of the top part of the instrument, being able to detect the amplitude of the motion within the vertical plane. It basically detects how high the musician is holding the instrument, a measurement that can vary between 0-180°. Similarly, the *tilt* component of the accelerometer will detect roll, determining when and how much the musician bends his/her body sideways. Here the amplitude of motion can be made to also vary between 0-180° degrees.

The *gyroscope* being a sensor that detects rotational acceleration is used in the META-EVI as a means of detecting fast movements of the upper torso, specifically when the musician swings his/her upper body while playing the instrument.

While the *force resistance sensor* (FRS) was mounted right by the ‘3rd valve’ of the MIDI EVI being comfortably accessed by the right hand pinky finger of the musician, the *3-membrane position sensor* - which consists of three small parallel strips that are able to independently detect the exact location where they are touched - was placed along the left side of the instrument. They allow the right hand of the musician to touch it with either the pinky finger or the thumb, while playing the three main MIDI EVI keys. They can also be touched simultaneously with up to three fingers of the right hand when the musician is not using the virtual valves.

The *joystick* was placed under the body of the instrument and it is controlled by the right hand’s thumb and the two *linear potentiometers* are placed inside the canister of the MIDI EVI.

They two potentiometers are accessed by the index and middle fingers of the left hand of the musician, the same hand that controls the octave the instrument is playing in as well as the half-octave of the MIDI EVI. The two potentiometers have a heavy usage in the extended instrument since they are controlled by the left hand of the performer, which is freer from the keying scheme.

The force resistance sensor, the 3-membrane position sensor, the joystick and the two linear potentiometers being independent from the player’s gestures allowed them to have a more extensive set of functions and to respond to multiple mapping options.



Figure 3. Canister view: 2 potentiometers and 3 switches

4.2 The digital switches

The META-EVI has a total of ten tactile switch buttons. Seven of those buttons are placed on top of the instrument easily accessible by the right hand fingers and the remaining three switches are imbedded in the canister wall. The placement of the three buttons within the canister was done as an attempt to fully maximize all the free fingers of the player's left hand. Many programming features had to be implemented to allow for the flexibility that the instrument presents. Therefore each switch responds to one simple click, a double click, one click holding it down either a short or longer time, thus giving two different readings, and a double click holding down the second click, again either a short or a longer time. This range of possibilities allows the performer to maximize the high number of tasks that the relatively small number of switches need to accomplish.

When programmed to respond to simple clicks, the 10 switches can be further explored by using switch combinations. This way they can be made to function as a 10 bit number generator, theoretically being able to generate 1024 different values. However, only a small fraction of these values are used - under one hundred different values. The narrowing of the number of switch combinations results from ergonomic constraints and also from practical limitations arisen from the need to memorize those combinations. Additionally, the three switches that are placed right across the three main virtual valves of the MIDI EVI can be made to function as a secondary brass keying scheme. This allows the musician to simultaneously play the normal melodic material with the three touch sensor keys while being able to trigger other events by using alternative switch combinations.

The extra sensors and switches of the META-EVI output small voltages within the range of 0-5 volts. They are housed within an acrylic structure that also holds the sensor interface, a MIDITRON [4] sensor interface. The analog signals captured by the interface are sent via MIDI to a computer running the Max/MSP programming language.



Figure 4. View of the Sensor Interface MIDITRON

5. PERFORMANCE MODES

The META-EVI was built to be capable of performing in a variety of different performance modes, separately or concurrently. These include:

- 1) Harmony mode
- 2) Counterpoint mode
- 3) Sample trigger mode
- 4) Looper mode

- 5) DSP mode(s)
- 6) Mix mode

Figure 5. Real time harmonization of a lead melody

1) Harmony Mode

In 'Harmony mode' the META-EVI is programmed to play truly complex and flexible harmonies. These include the choice, *in real time*, of 34 different chord types, in any key, their position (root, 1st inversion, etc), their voicing or internal ordering and their tessitura. The combination of these different chord attributes, allows a great variety of chord configurations to be created. The playback of harmonies is performed alongside the melodic material traditionally generated by the monophonic instrument, thus being able to allow the musician to accompany him/herself.

In this performance mode the sensors needed include the two potentiometers, the joystick, the seven top switches and the accelerometer. They are mapped so that the potentiometers control respectively the number of the notes of the chord and the chord inversion/position. The 3-membrane sensor chooses the "voicing", the joystick acting as a 8-way switch triggers different chord types and the accelerometer chooses the chord's octave. The 7 switches have multiple functions the most important of which are the alteration of specific notes within the chords thus allowing great flexibility for the configuration of the harmonic structures to be generated.

2) Counterpoint mode

The META-EVI is able to generate two or even three simultaneous strands of melodic material in real time. Any of these linear phrases can be further processed by having their note information trigger stacks of parallel chords. These features allow the creation of a very complex web of musical expression.

3) Sample trigger mode

Besides the two main performance tasks above mentioned, the META-EVI has been programmed to be able to access a large number of recorded sound files. It can control the playback of 64 samples at a time, being able to process them in real time as well. Current digital processes include: ring modulation, vocoding, multi-delays, filtering and granular sampling effects.

4) Looper mode

A live sampling recording technique was also implemented allowing the musician to record in real time a musical phrase, store it, play it back, and record new layers on top of it. The whole process can be repeated several times enabling the performer to create up to 8 independent layers of music materials. This performance mode relies exclusively on the use of the seven top switch buttons.

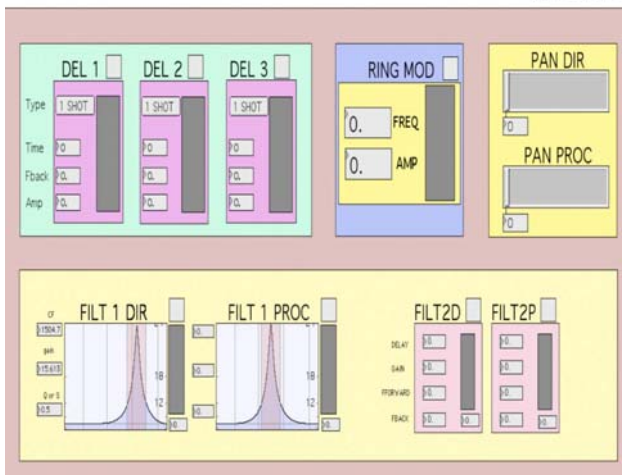
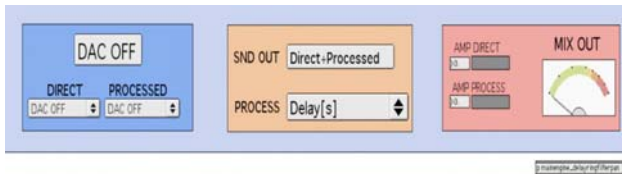


Figure 6. MSP patch for a DSP performance mode

5) DSP mode(s)

The META-EVI was also designed to control several different synthesis parameters within a given synthesis program. This is accomplished through both the extra sensors and the native sensors. In this mode the sensors that capture the musician's body motions have the unique function of closely translating the performance gestures with specific sonic changes. This mode was specifically developed with the second goal of the project in mind.

6) Mix mode

In this mode the instrument plays at the same time, in two or more of the previously described modes. This is by far the most challenging way to perform with the instrument, both technically and musically and it is under development.

6. CONCLUSION

The novelty of the META-EVI consists in the creation of an instrument with a high number of sensors capable of sending continuous and reliable gesture and control information in real time, while easily being able to reassign any of the sensors' information to any desired parameter in real time as well. These extra capabilities turn the already versatile expressiveness of the original MIDI EVI into a more powerful instrument that enables the performer to have a wider control of the sound that (s)he creates as well as being able to generate more complex musical structures that go far beyond simple monophonic playing.

7. ACKNOWLEDGMENTS

This project was funded by a 'sabbatical research grant' from both the Fundação para a Ciência e Tecnologia (FCT), and the Fundação Luso-Americana para o Desenvolvimento (FLAD).

I also would like to thank my father for his invaluable work with hardware design.

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